

1 **Highlights**

- 2 Few studies demonstrate ecological benefits of MPA governance
- 3 Some key studies participatory governance incorrectly assign ecological benefits
- 4 There is a need to link governance to ecological indices in MPA studies

Lack of evidence that governance structures provide real ecological benefits in marine protected areas

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Abstract

The Convention on Biological Diversity (CBD) has set targets for the total area of marine protected areas (MPAs), as well as targets to encourage a participatory approach to governance with equitable sharing of benefits of these areas to multiple stakeholders. These targets have contributed to a considerable volume of research in MPA governance, and in the ecological effectiveness of MPAs. However, examining the literature demonstrates there is very little joined up research to show that any particular governance approach results in improved ecological indices of fish stocks or biodiversity. Indeed, some of the well-cited examples of participatory governance implying improved ecological metrics are either incorrect (as data do not relate to MPAs under participatory governance systems), or do not provide any ecological data other than opinions of fishers to back up the claims. Evidence suggests that participatory governance approaches with equitable sharing of benefits can help the establishment and management of MPAs, and as such, there should be urgent further work assessing the ecological benefits that arise as a result of the establishment of MPAs with participatory and equitable governance approaches.

Key words: MPA, Biodiversity, Fish Stocks, Convention of Biological Diversity, Stakeholders

28 **Introduction**

29 The need for multidisciplinary research is now considered essential in conservation, yet here we
30 demonstrate that joined up multidisciplinary research relating to marine protected areas (MPAs) is
31 greatly lacking. Currently there is little evidence that equitable and participatory governance systems
32 for MPAs generate any biological benefit. Effective multidisciplinary research is needed to address
33 this evidence gap.

34

35 The concept of ‘conservation for people’ has displaced the former paradigm of ‘conservation despite
36 people’ in recent years (Mace 2014). Equitable governance of conservation for the benefit of multiple
37 stakeholders is now a major concern of organisations from the UN through to local government and
38 NGOs (van den Hove 2003; Marks & Hooghe 2004), and is participatory governance from a wide
39 range of stakeholders is embedded as a principle in the Convention on Biological Diversity’s
40 Programme of Work on Protected Areas (Borrini-Feyerabend et al. 2013). Alongside these proposed
41 governance structures are a suite of international agreements for nature conservation, such as the
42 Aichi targets, amongst which is the target to conserve 10% of marine habitats by 2020 (Bertzky et al.
43 2012; Edgar et al. 2014).

44

45 Traditionally the establishment of MPAs caused tensions and opposition within local communities,
46 especially with members of the fishing industry (reviewed by West et al. 2006; Mora & Sale 2011).
47 However, including local communities and fishers as participants within the governance structures
48 has frequently been shown to lead to greater acceptance of MPAs, along with other benefits such as
49 self-policing of the areas by the stakeholders (Defeo & Pérez-Castañeda 2003; McClanahan et al.,
50 2009; Taylor et al. 2013; Islam 2017). Jones (2014) provides a detailed overview of how multiple
51 stakeholders can create strong governance systems and facilitate establishment of MPAs.

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53 There is also an expanding literature on the ecological benefits of MPAs (Gell & Roberts 2003;
54 Halpern 2003; Sciberras et al. 2013; Costello & Ballantine 2015; Gill et al. 2017), where evidence

exists to demonstrate they can protect and enhance fish stocks, protect biodiversity and even provide economic benefit to fishers through the ‘spillover effect’ of increased fish outside the protected areas (Russ & Alcala 2011). However, MPAs differ greatly in size (from < 1 ha to 1000s km² – see data in West et al. 2006; Wood et al. 2008) and protection they offer (from ‘no take’ Marine Reserves through to so called ‘Paper Parks’, where almost any activity and unlimited harvesting of fish are allowed or guidelines are unenforced) (Wood et al. 2008; Edgar et al. 2014; Pieraccini et al., 2017). Small-scale ‘paper parks’ can show no ecological benefit (e.g. Stafford et al. 2016) and comprehensive reviews demonstrate that larger MPAs show the most benefit (Sciberras et al. 2013; Edgar et al. 2014). While there are benefits from partially protected areas in terms of fish stocks in these areas (Sciberras et al. 2013; Gill et al. 2017), fully protected marine reserves have been proposed to be necessary to adequately protect biodiversity (Costello & Ballantine 2015).

Given the working paradigm of ‘conservation for people’, and the Convention on Biological Diversity’s goals of equitable and participatory governance involving multiple stakeholders (Bertzky et al. 2012); this study investigates the relationship between research on governance structures of MPAs, involvement of multiple stakeholders, and the evidence of ecological benefits and protection the MPAs provide, through an examination of existing literature.

Examination of existing paradigms on the link between equitable governance and ecological success of MPAs

The CBD has been instrumental in research into participatory governance of MPAs (Borrini-Feyerabend et al. 2013; Jones 2014; see data below). The paradigm which appears to have been adopted is that MPAs are good for marine conservation (although see discussion in Jones 2014, which suggests that much of the basis of this paradigm is based around ‘no take’ MPAs), and establishing MPAs is easier (and more equitable, and contributes more to sustainable development goals) with participatory governance and equitable sharing of resources. In a CBD commissioned report, Kothari (2008) states: “Increasing evidence from around the world suggests that protected

83 areas are not only established as a key strategy for conservation of nature and wildlife, but are also
84 becoming important for addressing poverty and livelihood security. One of the common features of
85 many recent innovations is the notion of participatory or community based governance. Simply put,
86 the focus is on greater involvement of local communities, with net benefits for both conservation and
87 people.” Such statements clearly support this paradigm, but do not stand up to scrutiny.

88
89 The evidence for this statement comes from an analysis of two MPAs: Bunaken in Indonesia, and the
90 Apo Island in the Philippines. However, following the references given in the report to the original
91 source (Leisher et al. 2007), several inconsistencies arise.

92
93 Firstly, the evidence in Leisher et al. (2007) is primarily from a different reserve, Navakavu in Fiji, and
94 is based on hearsay from the local community, rather than scientific surveys: “People in Navakavu
95 fish just outside the marine protected area, and 80% of the people there say fish catches are better
96 than before the marine protected area was established.” Secondly, Leisher et al. (2007) do mention
97 the reserves in Kothari’s (2008) report, but with no reference or data to support the claims “The
98 spillover effect is also strong in Apo Island but slightly less so in Bunaken.” Subsequent investigation
99 of published literature indicates there are documented studies of spillover in Apo Island (e.g. Russ et
100 al. 2003), but little hard evidence to support improved fish stocks in Bunaken (Christie 2004). Thirdly,
101 while Apo Island did have community based governance until the mid-1990s, it subsequently has a
102 more ‘top down’ government controlled governance approach (Hind et al. 2010).

103
104 Clearly the statement in Kothari (2008) is poorly justified, and there is therefore a need for evidence of
105 ecologically effective MPAs to be linked to equitable governance. A recent and high profile study has
106 investigated the linkages between MPA management (of which a component of the management
107 ‘score’ assigned for each MPA was on non-state or mixed management systems) and fish stock
108 enhancement (Gill et al. 2017). The study demonstrated that the major limitation to success of MPAs
109 is a lack of funding for clear management and enforcement of the areas (Gill et al. 2017), indicating
110 on average, adequate budgets for policing and enforcing regulations of MPAs resulted in almost three

times the benefit of a typical MPA. No clear links with governance were found, but this may be due to the limited data on this, and as such the limited way these data were handled in the analysis. However, given that a possible benefit of participatory governance and equitable sharing of resources of MPAs is the role of self-policing (Defeo & Pérez-Castañeda 2003), this could provide support to the theory that participatory governance plays a role in MPAs ecological success.

In the Gill et al. (2017) study, out of the 589 MPAs studied worldwide, only 62 had both ecological (fish biomass) and management data associated with them. Of note is that for some MPAs such as Machalilla in Ecuador, there were relatively good measures of budget and management (equal to the median for all MPAs studied), but no ecological data to match to the analysis. Recent data demonstrate that there is no statistical difference in fish community structure between this long standing MPA, recently designated MPAs and non-designated neighbouring areas (Stafford et al. 2016). Although only a single example, it is possible that published datasets on fish biomass from inside MPAs may arise from a research or publication bias into the best performing areas (Caveen et al. 2015). Of further concern is the limited number of MPAs (~ 10%) which have both management information and easily available ecological data, making assessment of effective management of MPAs difficult to achieve.

Examining studies with a joint ecological and governance focus

To provide an overview of the typical research focus into governance of MPAs, an ISI Web of Knowledge search was conducted in April 2017. Using the search terms 'governance' and 'marine protected area*' to allow for plurals of the latter term, in the titles, topics and key words found a total of 448 papers. When this search was further refined to include 'biodiversity' the number of studies fell to 130, including 'biomass' resulted in just 11, 'fish stock' in 19 papers and when refined to include 'stock size' rather than biodiversity, fell to just 2 studies. This compares to 1,631 'marine protected area*' and 'biodiversity', 733 'marine protected area*' and 'biomass', 621 'marine protected area*' and 'fish stock*' 239 for 'marine protected area*' and 'stock size'. Although a snapshot, and not a

comprehensive list of every possible search term, these results indicate the huge mismatch between work including governance of MPAs alongside ecological metrics.

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To obtain a better idea of what is typically included in studies examining the governance of marine protected areas, the same search terms ('governance' and 'marine protected area*'), were searched for in article titles, yielding a total of 30 results. On inspection of these, one was off topic and discarded and one result duplicated, two were editorials for special issues of journals and one a book review, giving a total of 25 papers (full details in Table 1).

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Twenty of the papers detailed governance structures, 21 were case studies of particular MPAs or country level reviews and four were reviews of governance in general. However, the results demonstrated little in the way of evidence of different success measures of governance or ecological metrics. Seven studies indicated evidence of high levels of stakeholder engagement, and two detailed social benefits provided by the MPAs. Nine papers raised problems and concerns over governance and management measures.

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While it is important to assess the success of MPAs against their ecological objectives (for example, protecting biodiversity is a different objective to enhancing fish stocks), only four papers showed any more than a cursory overview of ecological benefits (e.g. more than citations to previous studies of MPA benefits in general in the introduction). Of these one was a review, and therefore did not link ecological benefits to socio-economic factors at any particular site (Bennett & Dearden 2014a), one was a review of UK MPAs and demonstrated that a voluntary reserve was not working and had subsequently been taken into top-down governance (Jones 2012), and one was more an overview of seabird ecology than examining different governance structures explicitly (Yorio 2009). One paper did provide direct reference to studies showing changes in ecological indices, although these were negative changes rather than positive (Day & Dobbs 2013). As such, none of the 25 papers demonstrated any biological benefit, yet alone benefit measured against the ecological objectives, of

the MPAs as a result of any governance, and especially of participatory governance. Most did mention the ecological benefits of MPAs in the introduction, but presented no evidence of increased biomass, stock sizes, biodiversity or any other ecological metric specific to the MPA(s) in the studies themselves. While this is not, nor is it intended, to be a full systematic review of the literature, it does clearly and unambiguously highlight the mismatch between research focus in the MPA literature.

The vast majority of the examined work on governance of MPAs has occurred since 2007, with only two studies in the analysis preceding this. Case studies on a local or country level, with a description of governance structures have been common over the last ten years (Table 1). However, investigation of participatory governance and identification of issues with governance appear to have been more prevalent in studies published since 2012. This presumably stems from the publication of protected planet report published in 2012, indicating a specific target for equitable governance of MPAs (Bertzky et al. 2012).

Jones et al. (2011) produced a comprehensive report of governance of MPAs with 20 case studies considered from around the world. From these case studies, eight provide no evidence or mention of ecological indicators (i.e. increases in stock sizes, biomass or biodiversity), a further two indicate it is too early to assess ecological effects, and a further four only supply anecdotal information (with no data or references to support the claims, in this case, of no improvement in ecological indicators). Only six of the 20 sites provide evidence of ecological indicators with data or references to published studies, with five of these six reporting benefits to at least one species or group of species in the reserve. However, it should be noted that success of governance was measured by changes in management or behaviour of the users of the MPA. Such changes are the immediate changes occurring from successful governance, with ecological changes occurring subsequently from management or behavioural change (discussed in detail in Jones 2014). It should also be noted that many of these case studies have been published, and where the search terms used in this study were included in article titles, the published research is also included in the analysis in Table 1.

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193 These analyses are not intended to dispute the work on governance conducted in the reports and
194 papers examined, but is intended to display the lack of integration between examination of
195 governance and ecological benefits of MPAs. They highlight the extent of the mismatch, but do not
196 conclude that studies on governance never consider biological indices. Indeed, in later work on these
197 case studies included in Jones et al. (2011), there is detail of how three of these MPAs have shown
198 ecological resilience compared to non-protected sites from external factors such as climate change
199 (i.e. fewer coral bleaching events, fewer crown of thorn starfish outbreaks and reduced anoxia and
200 increased abalone egg production – reviewed in Jones 2014). Furthermore, studies in Jones et al.
201 (2011) do identify human behavioural change or changes in management as a result of governance
202 (e.g. changes in fishing practices). Such changes are likely to benefit ecological indices, but in many
203 cases, there is simply a lack of evidence that this has occurred. As such, it is not intended to suggest
204 from the data obtained that participatory governance is bad for marine protected areas, just that the
205 ecological benefits are poorly studied in relation to governance structures.

206

207 **Consequences of equitable governance and diversification of livelihoods**

208 It is generally accepted that many fisheries are overexploited (Pauly & Zeller 2016), although there
209 are examples of well managed and sustainable fisheries throughout the world (Hilborn and Hilborn,
210 2012). Participatory governance, involving multiple stakeholders in the establishment of MPAs, has a
211 possibility of perpetuating the status quo of communities relying on ultimately unsustainable fishing
212 practices. However, there is evidence that local communities may not be as dependent on fishing as
213 previously thought (Jones et al. 2014), especially if a maritime-based community is formed (e.g.
214 fishers can still rely on the sea for their livelihood). Diversification of livelihoods can result in improved
215 benefits for natural resources and wildlife (Ellis & Allison 2004). Examples of this include the
216 development of ecotourism, such as whale watching, SCUBA diving and snorkelling trips (e.g.
217 Stafford et al. 2016). However, such approaches need to be developed with care (Brockinton et al.
218 2008; Jones 2014). Predictions for the economic benefit provided to the local community from
219 livelihood diversification from fishing to tourism in mainland Ecuador indicated that to maximise

benefits to wildlife and the local economy would require education and investment at the local level. Failure to deliver this investment at the local level would either lead to exploitative ecotourism (poorly regulated diving and whale watching delivering smaller financial returns and damaging the marine environment), or the 'buy in' of national or international tourism companies, preventing offset of economic loss through fisheries (Stafford et al. 2016). Nevertheless, simple acceptance of the status quo within a fishing community is unlikely to address long-term or larger-scale marine conservation concerns, especially outside the confines of an MPA.

Conclusions

MPAs are an important component of contemporary marine conservation, and their use is embedded in international agreements. The evidence surrounding the ecological benefits of MPAs are clear and increasing, but are not unequivocal (Caveen et al. 2015). Indeed, the nature of bias against negative results in scientific publishing may even prejudice against studies showing little or no effect of MPAs (Caveen et al. 2015).

Alongside the CBD targets for the percentage cover of MPAs are targets for governance and management of the MPAs. In general, participatory governance structures, result in multiple use reserves which are preferred by the fishing community (Suman et al. 1999; Helvey 2004), and hence are more likely to be established where legislative frameworks for conservation are less developed. However, multiple use MPAs are considered worse (but certainly not entirely ineffective) in protecting ecological parameters than full 'no take' marine reserves (Sciberras et al. 2013; Costello & Ballantine 2015; Gill et al. 2017). As such, it is unreasonable to conclude that participatory governance of protected areas is unable to adequately protect marine wildlife and biodiversity in MPAs, however, there is scant evidence that this is the case, and some evidence that the level of protection is not as great as it may be thought. This study therefore is a clear call for properly conducted multidisciplinary research around MPAs, ensuring studies on the governance or management of MPAs also properly consider the ecological benefits occurring in the MPAs in question, that the measured benefits are

247 appropriate to the objectives of the MPA, and that studies indicating ecological benefits of MPAs also
248 investigate and report on management and governance structures.

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414 Table 1. Key topics (indicated by +) covered by papers containing search terms 'governance'
 415 and 'marine protected area*' in the title from a Web of Science search in April 2017.

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Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Details of Governance Structure	+	+	+	+		+	+	+		+	+	+	+	+	+	+	+	+			+	+			+
Site to country level study of Governance	+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+		+				+	+
Review of Governance				+		+																+	+		
Evidence of equitable governance (stake holder engagement)	+				+							+			+	+	+				+				
Social Benefits (+ improved, - worse)					+			a				+			+										
Identified issues with Governance Structure		+	+		+					+			+	+				+				+			
Discussion of ecological benefits						+					b			c		+				+					
Year of study	2017 - 2016				2014				2013							2012		2010		2009		2007		1999 - 1998	

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418 a) Decline in social benefits reported

419 b) Reference given in paper to report indicating decline.

420 c) Methods indicate data on fish catch were taken, but no results of this

421 1. Islam et al. 2017. 2. D'Anna et al. 2016. 3. Ramirez 2016. 4. Duda 2016. 5. Horigue et al.

422 2016. 6. Bennett and Dearden 2014a. 7. Ho et al. 2014. 8. Gruby and Basurto 2014. 9. Bennett

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